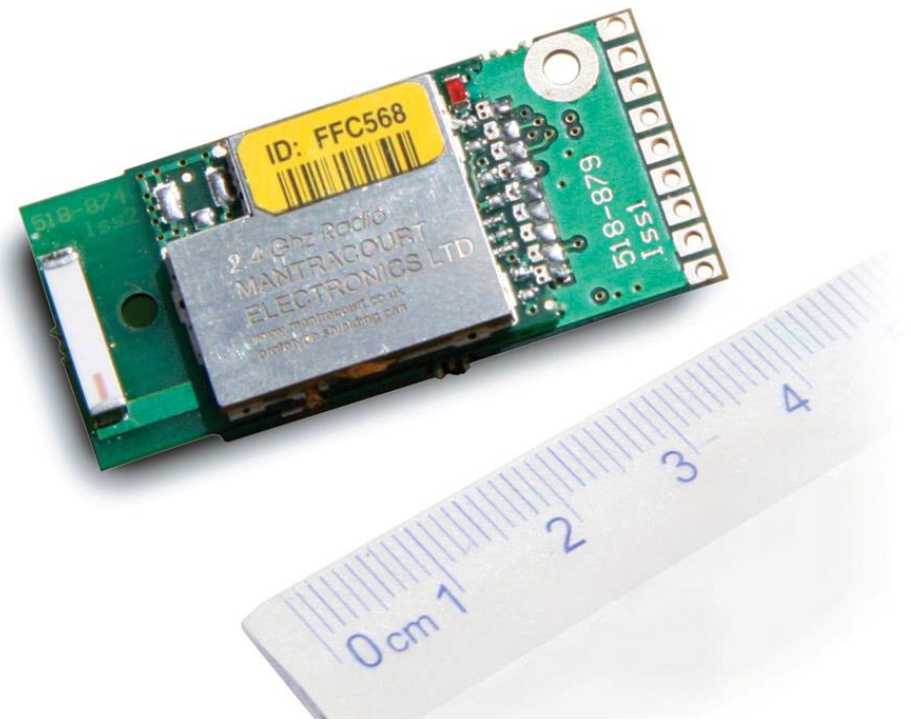

T24-PA

Pulse Acquisition Module

User Manual
mantracourt.com

mantracourt

Wireless Telemetry Range 2.4Ghz

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Introduction / Overview

The T24-PA is a remote acquisition module for the collection and processing of pulse related measurements. This includes measuring the period between pulses to provide outputs in Hz, RPM and Time as well as actual pulse counting. The module senses the input for a user defined time and then periodically transmits the data.

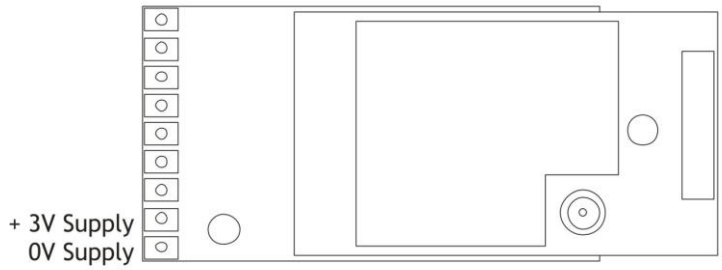
Various devices are available that utilise the transmitted data and include handheld and PC displays etc.

Connections

This section will show you how to get the device pair working out of the box.
You will require a 3 Volt dc supply for the acquisition module which may be 2 X AA alkaline batteries.

Power

Attach power supply wiring to the module as shown below:



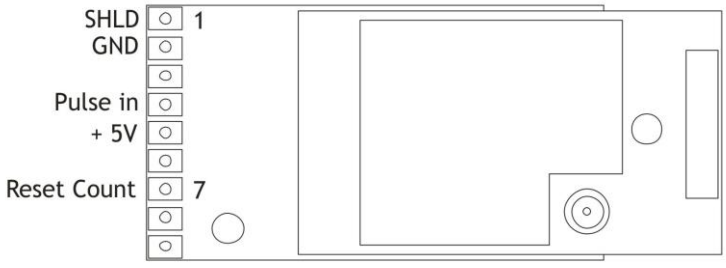
Connect to a 3 Volt power supply or batteries.

WARNING: This module is not reverse polarity protected!

WARNING: The maximum voltage is 3.6V!

Input Connections

NOTE: The acquisition module may already be mounted in a connectivity module. In this case please refer to the connectivity module user manual for the connection details.



The ‘Pulse in’ input incorporates a pull-up resistor enabling a ‘volt-free’ contact to be used as the input source. This can take the form of a normally open or normally closed switch or relay contacts.

A normally open contact connected between ‘Pulse in’ and ‘GND’ will generate a negative edge when it operates. In this case set ‘Edge Type’ to ‘Falling’ in the ‘Input/Output Configuration’ page of the T24 Toolkit.

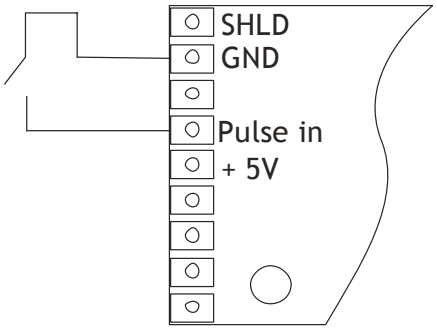
‘Edge Type’ should be set to ‘Rising’ to accommodate a normally closed contact when it opens.

The T24-PA can also be used with a repetitive sine, square or pulse wave signal source such as a signal generator or RPM sensor. The amplitude should be between 0.8V and 6V peak.

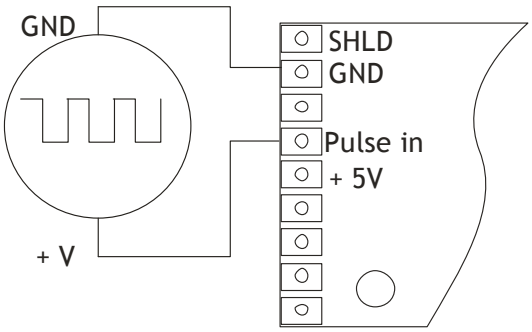
A maximum of 40mA can be drawn from the ‘5V’ supply pin to power a pulse generating sensor. By setting a value in ‘Startup Time’ in the T24 Toolkit ‘Advanced Settings’ page the time taken for the sensor to start up and become stable after a ‘sleep’ period can be accounted for by delaying the sampling until this period has elapsed.

Reset Count is a ‘volt-free’ contact input. This can be used to reset the count input to zero. To activate connect ‘Reset Count’ to GND.

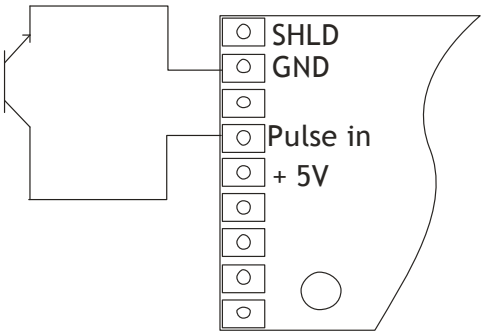
Relay & Volt Free Contact



Voltage Source



NPN Open Collector



Configuration

This section explains how to install software and configure the module. Please note that you will need the T24 Toolkit software and a T24-BS base station to allow your computer to communicate with T24 telemetry devices.

Installation

T24 Toolkit

To configure the devices we must use the **T24 Toolkit** software application. This can be downloaded from our web site or may be shipped with your products.
Install this on a PC or laptop.
Run setup.exe and follow the prompts to install the software.

T24-BSu Base Station

If you have a USB version of the base station (T24-BSu) then you just need to plug this into a USB socket on your PC. If you are using an alternative base station then please refer to the appropriate manual.

T24 Toolkit

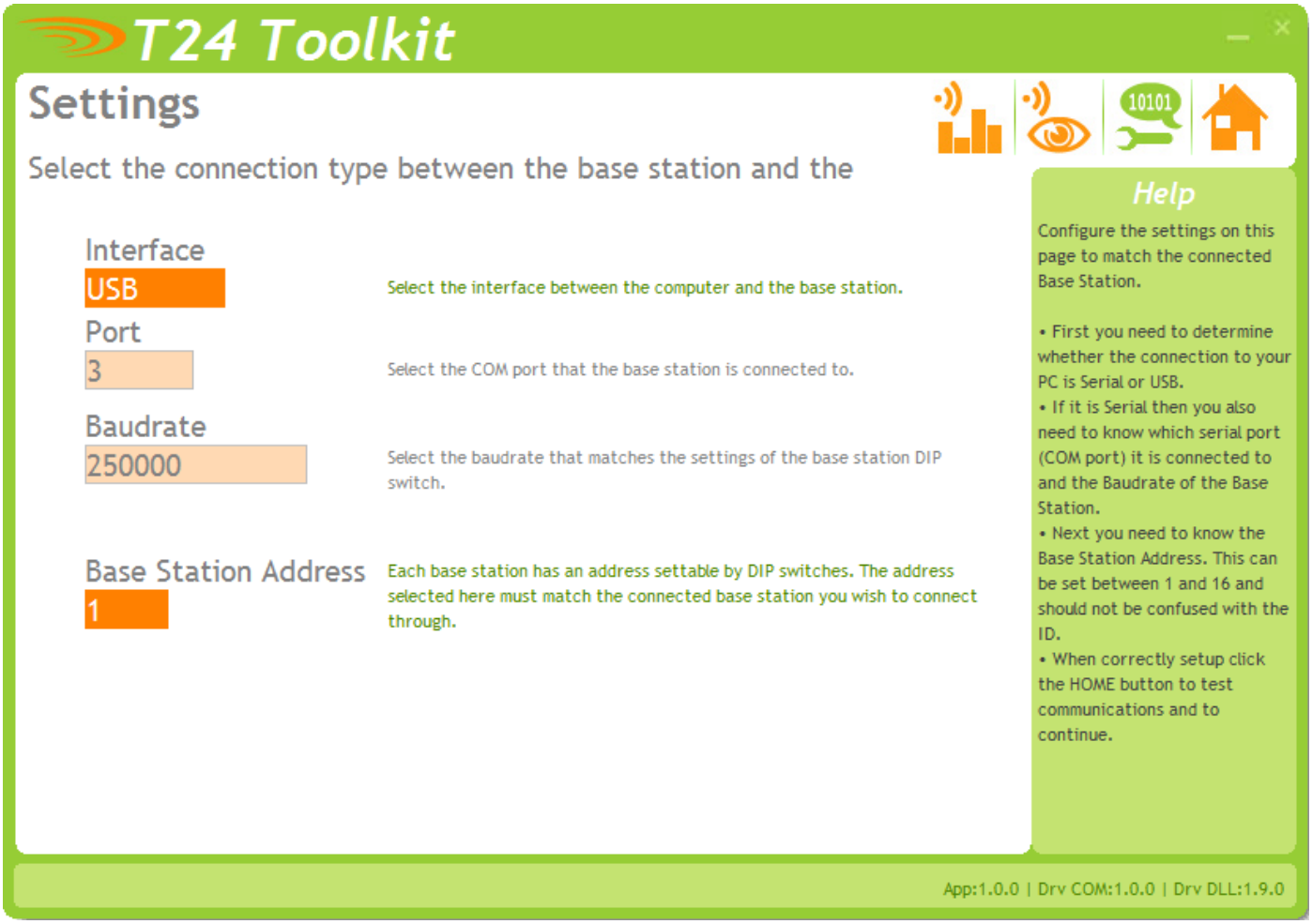
The T24 Toolkit provides a means of simple configuration and calibration of the acquisition module along with useful tools to aid integration.

Run the T24 Toolkit software application.

PLEASE NOTE: Depending on which acquisition module is selected the screenshots may vary slightly. This will generally be in naming of units and device descriptions. The screenshots shown are those shown when a T24-PA strain gauge acquisition module is connected.

General Pages

Setup Base Station Communications


T24 Toolkit
Settings
Select the connection type between the base station and the
10101
Help
Configure the settings on this page to match the connected Base Station.
• First you need to determine whether the connection to your PC is Serial or USB.
• If it is Serial then you also need to know which serial port (COM port) it is connected to and the Baudrate of the Base Station.
• Next you need to know the Base Station Address. This can be set between 1 and 16 and should not be confused with the ID.
• When correctly setup click the HOME button to test communications and to continue.
Interface
USB
Select the interface between the computer and the base station.
Port
3
Select the COM port that the base station is connected to.
Baudrate
250000
Select the baudrate that matches the settings of the base station DIP switch.
Base Station Address
1
Each base station has an address settable by DIP switches. The address selected here must match the connected base station you wish to connect through.
App:1.0.0 | Drv COM:1.0.0 | Drv DLL:1.9.0

Select **USB** as the interface and select 1 as the Base Station Address.
In the toolkit all items that can be changed by the user are coloured orange.
To change a value just click on the relevant orange item. You will then be presented with a new dialog window allowing you to change the value.
This may use a slider, text box or list to allow your new value to be entered.

Click the Home button to attempt communications with the base station.
If no communications can be established the toolkit will remain on this page. You will need to check that the base station is powered and that it is connected to the converter correctly.

Home

T24 Toolkit
Home
Monitor or Log
You can view and log the data being transmitted from an acquisition module or view the spectrum analyser by clicking the icons above right. Pairing is NOT required to log data from your device.
Configure your device
To configure your module we need to temporarily pair to it. When we pair from the Toolkit we configure the base station radio settings to match the remote module.
To pair you must:
· Remove the power from your module.
· Initiate the pair by clicking the button below.
· Re-apply the power to the module.
When applying power be careful to do this cleanly because if the module is powered up with an intermittent connection it may reset during pairing and result in poor or no communications.
Pair
If the module cannot be paired because access to the power supply is either not possible or many modules share the same power supply. Click Here for advanced connection options.
Help
This Home page is where you begin your connection to your device.
You must be able to access its power supply so you can remove and reapply it.
The device you want to connect to must be the only device you reapply power to.
When pairing to a device the base station settings are changed to match those of the remote device.
[To connect to the base station hold the Shift key while clicking the Pair button]
Connected to Base Station of ID FFC8FF on channel 3
App: 1.2.0 | Drv COM: 1.7 | Drv DLL: 2.6

We now have successful communications with the base station so we can now pair with our device or we can select the Spectrum Analyser mode or Data Provider Monitor mode.

To connect to our device we will pair. This is achieved by power cycling the device. Pairing removes the need to know the radio settings of the device you are connecting to and also ensures that it is in a suitable state for configuration.

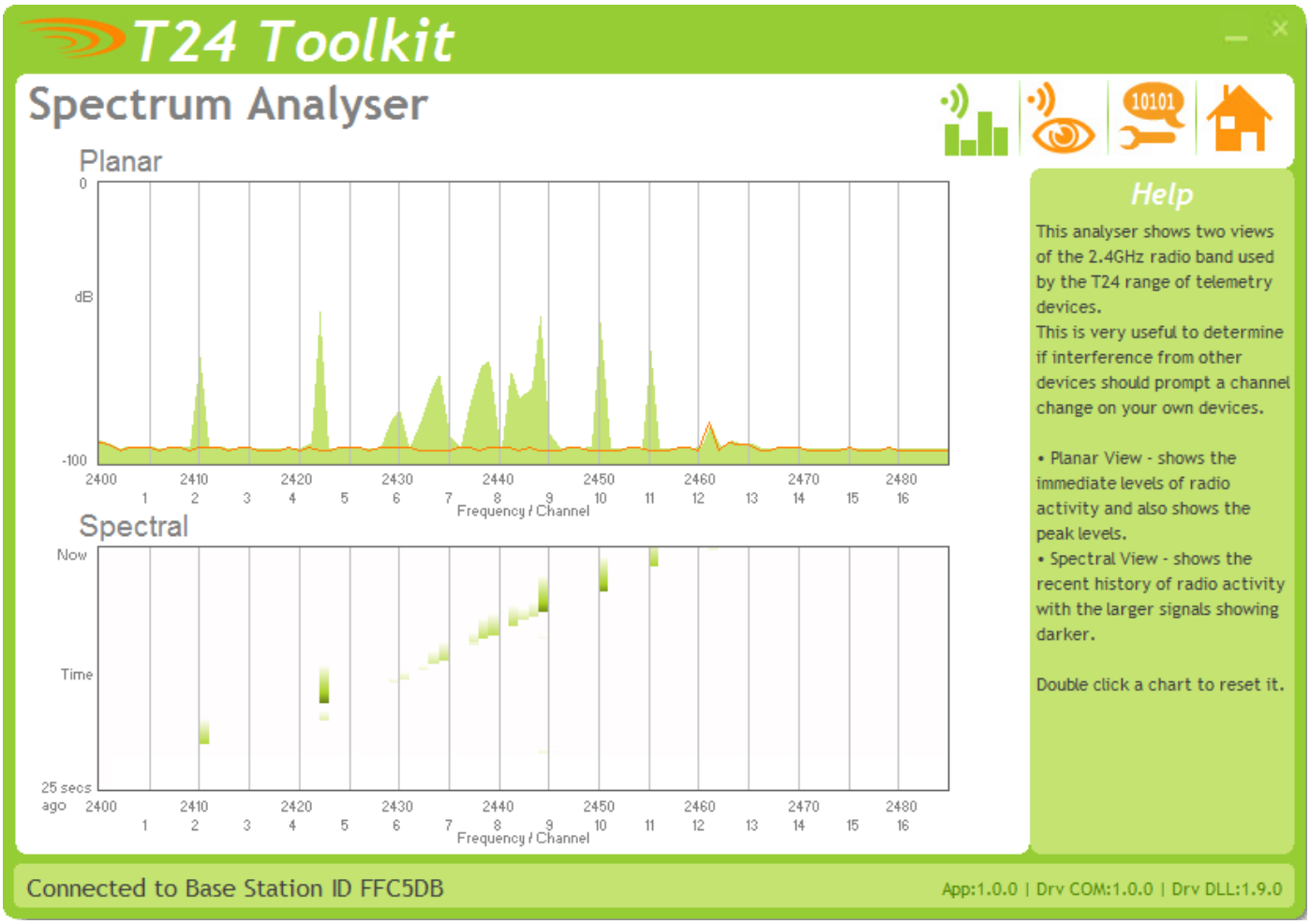
Pairing Procedure

- Remove power from the acquisition module
- Click the Pair button on the toolkit.
- You now have 10 seconds to re-apply power to the acquisition module.

If you connect successfully the toolkit will change to the Information page.
If the pairing fails try again.

NOTE: Pairing with the toolkit will **not** change the radio configuration settings of the connected device.

Analyser

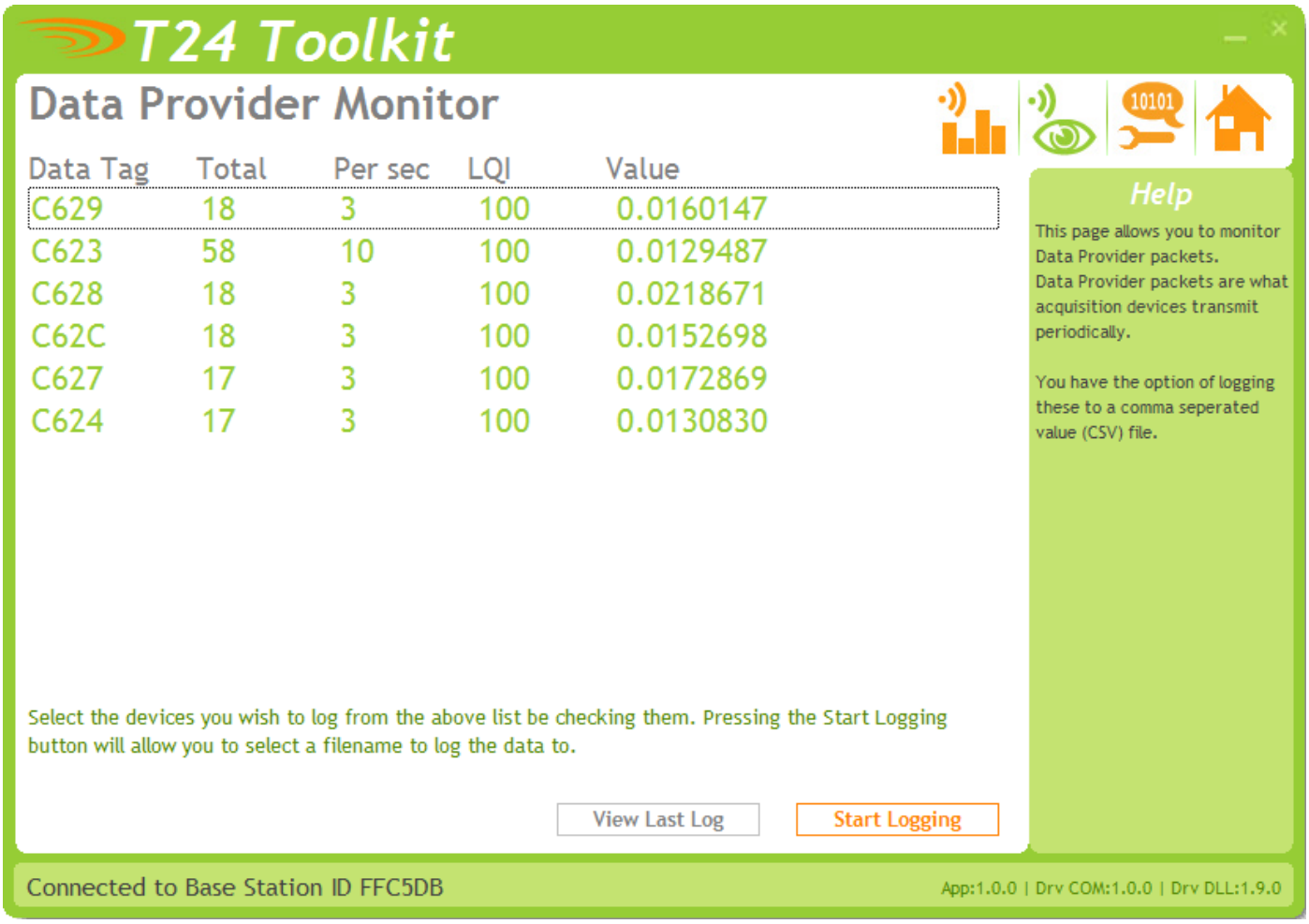

T24 Toolkit
Spectrum Analyser
Planar
0
dB
-100
2400 2410 2420 2430 2440 2450 2460 2470 2480
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Frequency / Channel
Spectral
Now
Time
25 secs ago
2400 2410 2420 2430 2440 2450 2460 2470 2480
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Frequency / Channel
10101
Help
This analyser shows two views of the 2.4GHz radio band used by the T24 range of telemetry devices.
This is very useful to determine if interference from other devices should prompt a channel change on your own devices.
• Planar View - shows the immediate levels of radio activity and also shows the peak levels.
• Spectral View - shows the recent history of radio activity with the larger signals showing darker.
Double click a chart to reset it.
Connected to Base Station ID FFC5DB
App:1.0.0 | Drv COM:1.0.0 | Drv DLL:1.9.0

The analyser page is provided as a tool and will not normally be needed unless you plan to change channels and want to find the best channel to select, or to diagnose poor communications issues.

This page shows the radio signal levels detected across all the channels available to the T24 series of devices. Using this tool may help in detecting noisy areas and allow you to decide on which channels you may want to use.

The above charts show the traffic from a Wi-Fi network and it can be seen to be operating over channels 6 to 9 and it would be best (though not essential) to avoid using these channels.

Data Provider Monitor


T24 Toolkit
Data Provider Monitor
Data Tag Total Per sec LQI Value
C629 18 3 100 0.0160147
C623 58 10 100 0.0129487
C628 18 3 100 0.0218671
C62C 18 3 100 0.0152698
C627 17 3 100 0.0172869
C624 17 3 100 0.0130830
Help
This page allows you to monitor Data Provider packets.
Data Provider packets are what acquisition devices transmit periodically.
You have the option of logging these to a comma seperated value (CSV) file.
Select the devices you wish to log from the above list be checking them. Pressing the Start Logging button will allow you to select a filename to log the data to.
View Last Log
Start Logging
Connected to Base Station ID FFC5DB
App:1.0.0 | Drv COM:1.0.0 | Drv DLL:1.9.0

T24 acquisition devices normally operate in low power mode and periodically transmit Data Provider packets
This page shows all detected Data Provider packets which may be useful for checking that a device is operational.

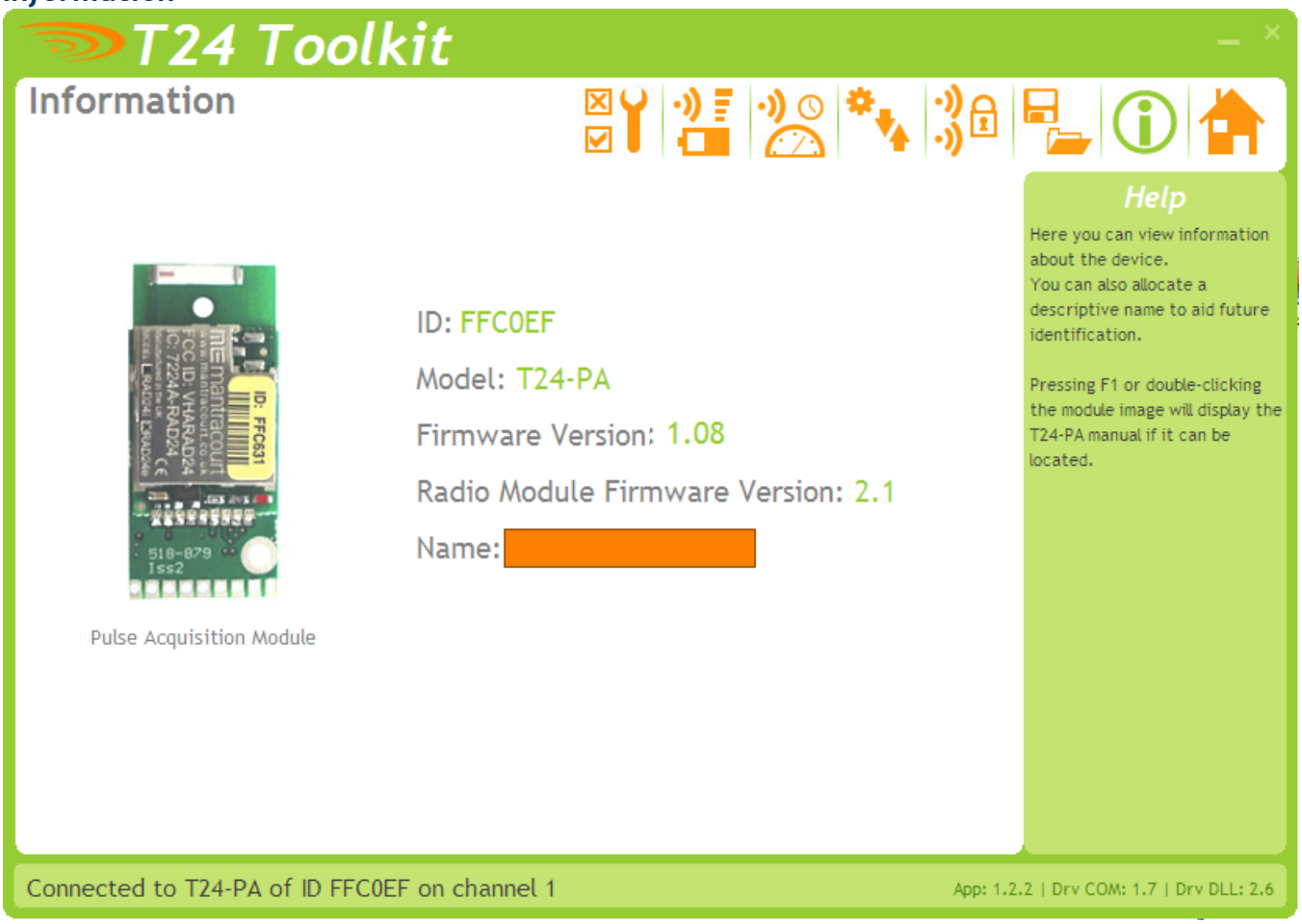
NOTE: When the toolkit connects to a device to enable configuration it will usually inhibit the transmission of Data Provider packets.

The Start Logging button will ask for a filename and proceed to log the received data to a CSV file in the following format:

```
Data Tag, Elasped mS, Value
```

The View Last Log button will launch the application associated with CSV files and open the last logged file.

Information

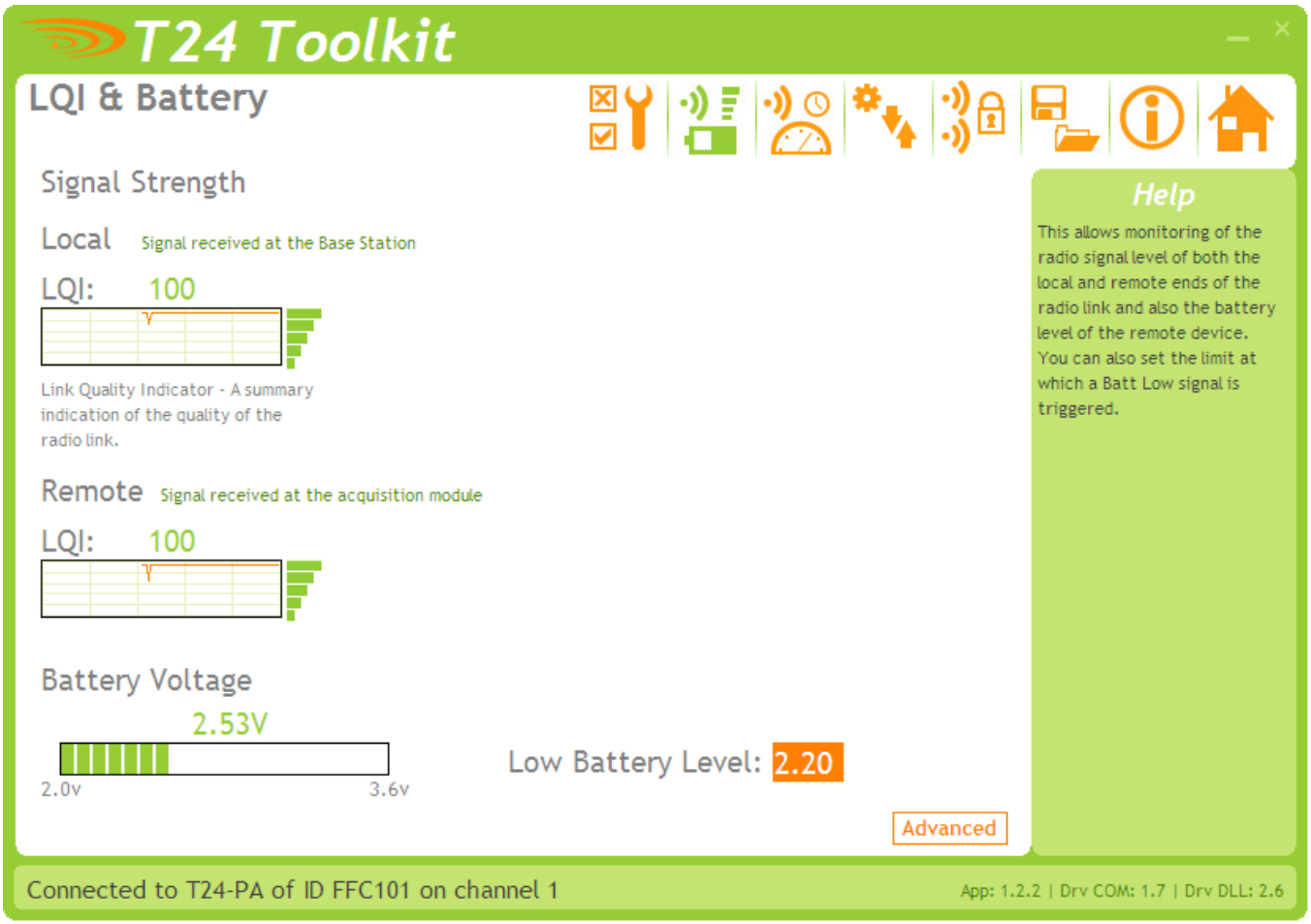

T24 Toolkit
Information
Help
Here you can view information about the device.
You can also allocate a descriptive name to aid future identification.
Pressing F1 or double-clicking the module image will display the T24-PA manual if it can be located.
ID: FFC0EF
Model: T24-PA
Firmware Version: 1.08
Radio Module Firmware Version: 2.1
Name:
Pulse Acquisition Module
Connected to T24-PA of ID FFC0EF on channel 1
App: 1.2.2 | Drv COM: 1.7 | Drv DLL: 2.6

Once successfully paired to a device this page is displayed.
This page shows you information about the connected device.

Items you can change:

Name — You can enter a short description which may help you recognise this device in the future.

Battery and Radio Levels


T24 Toolkit
LQI & Battery
Signal Strength
Local
Signal received at the Base Station
LQI: 100
Link Quality Indicator - A summary indication of the quality of the radio link.
Remote
Signal received at the acquisition module
LQI: 100
Battery Voltage
2.53V
2.0v
3.6v
Low Battery Level: 2.20
Advanced
Help
This allows monitoring of the radio signal level of both the local and remote ends of the radio link and also the battery level of the remote device. You can also set the limit at which a Batt Low signal is triggered.
Connected to T24-PA of ID FFC101 on channel 1
App: 1.2.2 | Drv COM: 1.7 | Drv DLL: 2.6

Here you can see the voltage of the battery and the radio signal levels at the base station and the remote acquisition module. This simple view gives an LQI value which stands for Link Quality Indicator. This value will range from 0 to 100 and within this band you should still achieve communications. As the level drops towards zero communications may become intermittent but still achievable.

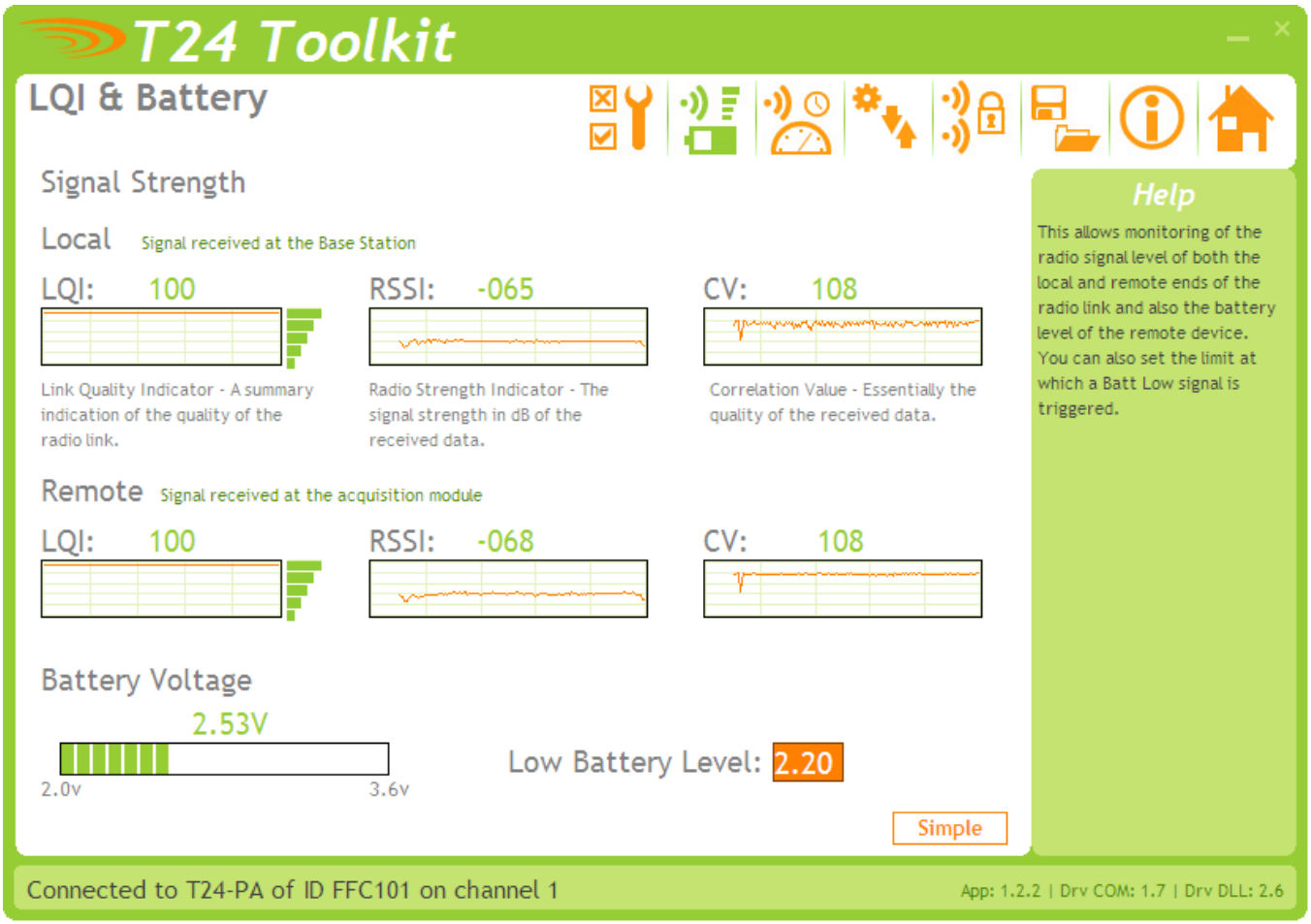
You can set the level at which the acquisition module reports a low battery.
If the battery voltage is below the Low Battery Level the bar will be coloured orange.

Items you can change:

Low Battery Level	Click this item to set the battery low level.

Clicking the Advanced button will give more detailed information on the RSSI and CV levels of the received radio packets.

Battery and Radio Levels Advanced Settings


T24 Toolkit
LQI & Battery
Signal Strength
Local
Signal received at the Base Station
LQI: 100
RSSI: -065
CV: 108
Link Quality Indicator - A summary indication of the quality of the radio link.
Radio Strength Indicator - The signal strength in dB of the received data.
Correlation Value - Essentially the quality of the received data.
Remote
Signal received at the acquisition module
LQI: 100
RSSI: -068
CV: 108
Battery Voltage
2.53V
2.0v
3.6v
Low Battery Level: 2.20
Simple
Help
This allows monitoring of the radio signal level of both the local and remote ends of the radio link and also the battery level of the remote device. You can also set the limit at which a Batt Low signal is triggered.
Connected to T24-PA of ID FFC101 on channel 1
App: 1.2.2 | Drv COM: 1.7 | Drv DLL: 2.6

LQI value which stands for Link Quality Indicator. This value will range from 0 to 100 and within this band you should still achieve communications. As the level drops towards zero communications may become intermittent but still achievable.

RSSI is effectively the received dB level which will range from about -30 which is a good signal to -90 which is a weak signal.

CV is the correlation value and indicates how well the signal can be decoded. This ranges from 55 which is a poor quality signal and 110 which is an excellent signal.

Data Rates and Quality

T24 Toolkit
Data Rate
Transmit Interval (ms)
1000
Enter the interval between taking a measurement and transmitting the result. Default = 300
Sample Time (ms)
100
The longer the sample time the more accurate the readings but the less life will be achievable from the battery. Default = 5
Low Power Mode
Yes
When Low Power mode is active the device semi-sleeps between transmissions so battery life is vastly increased. Default = Yes
Help
Here you can adjust data rates and quality and see the effect your choices have on battery life.
The battery life guide is only an indication of battery life and there are many factors that can affect this which are not accounted for here.
The guide assumes ideal operating conditions at 20 degrees centigrade and that capacitor modules are fitted when using alkaline batteries.
Please refer to device manual for more information.
Battery Life Guide
Battery Type
Select a common battery type or enter a custom capacity.
Usable Capacity (Ah)
2 X Alkaline D Cell 1.5V (Duracell LR20)
10
Sensor mA from 5V excitation
0
Usage Per 24 Hour Period (Hours)
24
Noise Free Resolution: Not Applicable
Battery Life: 2 months and 19 days
Connected to T24-PA of ID FFC101 on channel 1
App: 1.2.2 | Drv COM: 1.7 | Drv DLL: 2.6

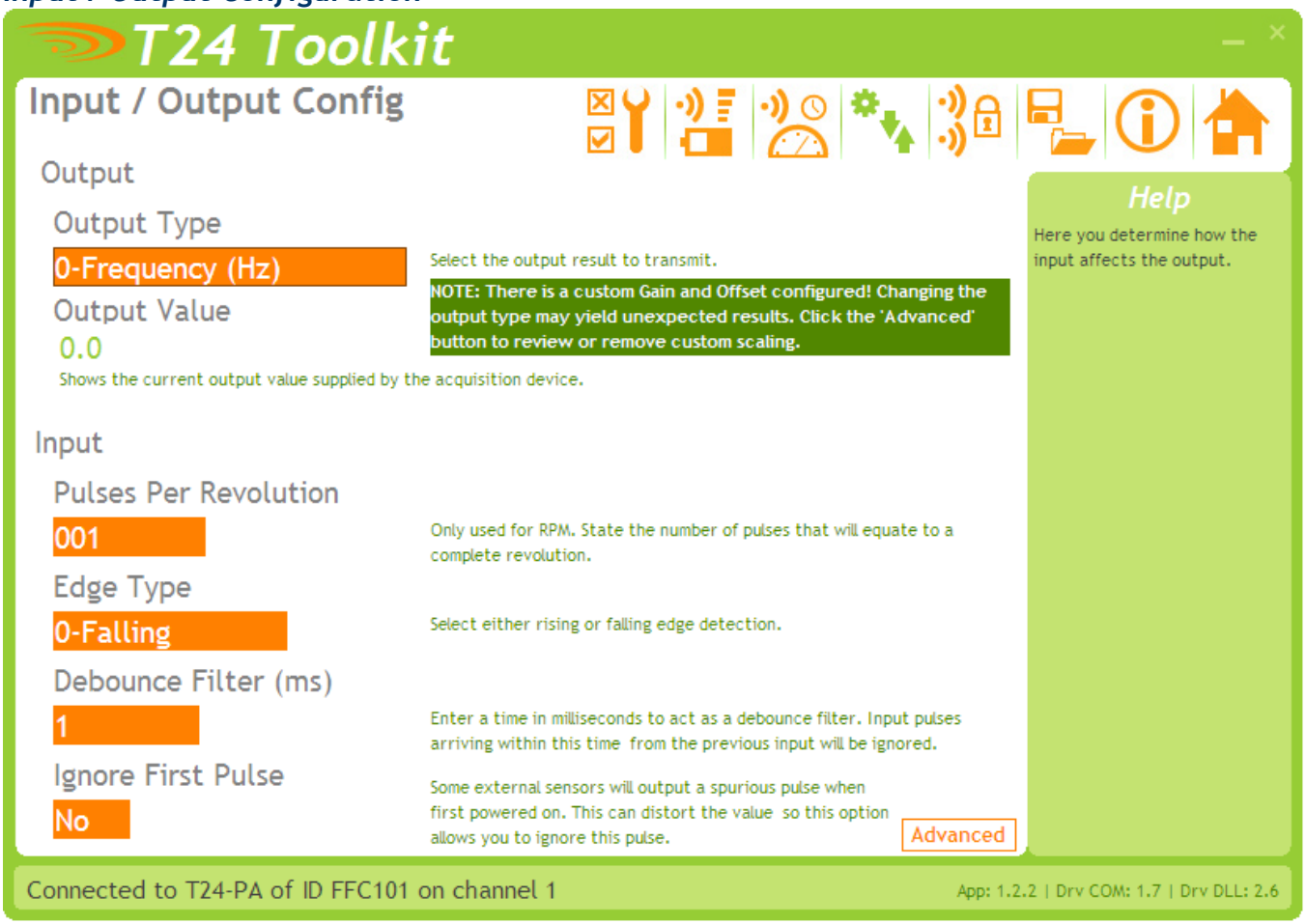
This page allows you to select the rate at which data is transmitted from the acquisition module and the quality. By selecting low power mode and entering some other information the toolkit will also give guides on achievable battery life.
Note that the battery life calculator is assuming the best case scenario which is at 20°C and that the battery has a suitable low internal resistance or that a suitable capacitor is fitted across the battery. See battery details in the Installation section.

Items you can change:

Transmit Interval	Enter the transmission rate in milliseconds. The default is 300 giving approximately 3 per second which is ideally suited to reading on a handheld. You may want to slow this down to achieve longer battery life.
Sample Time	This is the length of time in milliseconds that the input is sampled before the value is transmitted. This can vary between 5 milliseconds and close to the Transmit Interval. A shorter sample time means that the device is awake for less time so battery life is increased but at the expense of a reading with less noise free resolution. You can vary this to see the effect on battery. **Note: The Sample time should be set to twice the maximum time period that is to be captured to ensure accurate capture of incoming pulses.**
Low Power Mode	Unless the acquisition module is non battery powered this should be set to Yes. In between transmissions the acquisition module will enter sleep mode which, for some modules such as the strain gauge acquisition module, will have a massive effect on battery life. A Reason for **not** using Low Power Mode would be if using the device in a Master-Slave arrangement with PC for example.

Battery Type	This is not a parameter of the device but information used by the battery life guide. You can choose from some preset batteries or choose custom to allow you to select your own battery capacity. See below. This will also offer to change the Battery Low Level if the level suitable for the chosen battery is not the level currently set.
Usable Capacity	This is not a parameter of the device but information used by the battery life guide. This is the capacity of the battery in Amp Hours and has a profound effect on battery life calculations. This capacity needs to be calculated from battery manufacturer's data sheets to take into account that we can only use batteries down to 2.1 Volts so in the case of twin AA cells this would be 1.05 Volts. Generally the usable capacity will not be as high as that advertised by the battery manufacturer. Temperature and internal resistance of the battery are not taken into account in the guide.
Sensor mA from 5V Excitation	This is the current drawn by any sensor attached to the 5V onboard power supply.
Usage Per 24 Hour Period	Enter the number of hours per 24 hour period that the T24-HS handheld will be turned on and communicating with an acquisition module.

Input / Output Configuration

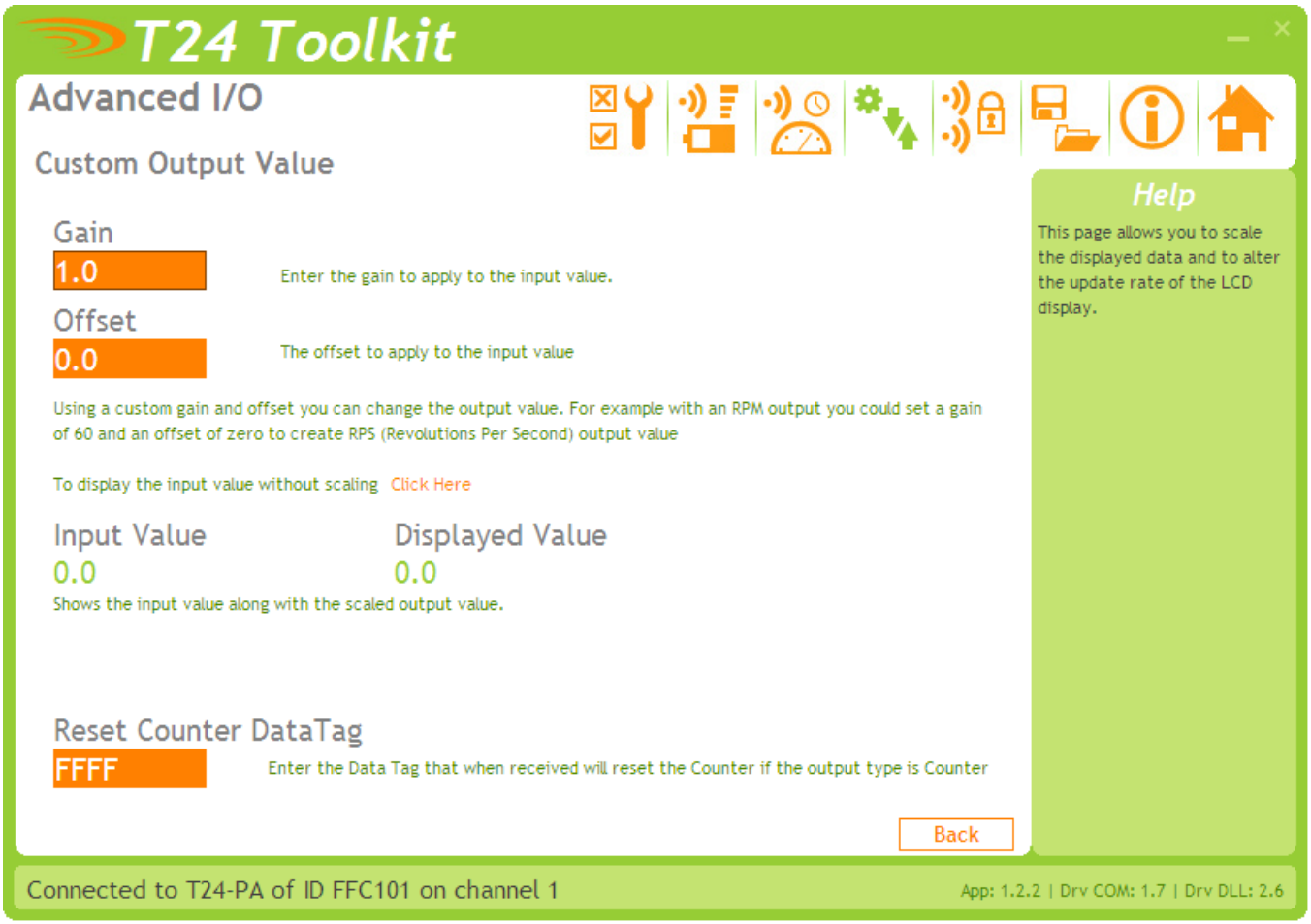

T24 Toolkit
Input / Output Config
Output
Output Type
0-Frequency (Hz)
Select the output result to transmit.
NOTE: There is a custom Gain and Offset configured! Changing the output type may yield unexpected results. Click the 'Advanced' button to review or remove custom scaling.
Output Value
0.0
Shows the current output value supplied by the acquisition device.
Input
Pulses Per Revolution
001
Only used for RPM. State the number of pulses that will equate to a complete revolution.
Edge Type
0-Falling
Select either rising or falling edge detection.
Debounce Filter (ms)
1
Enter a time in milliseconds to act as a debounce filter. Input pulses arriving within this time from the previous input will be ignored.
Ignore First Pulse
No
Some external sensors will output a spurious pulse when first powered on. This can distort the value so this option allows you to ignore this pulse.
Advanced
Help
Here you determine how the input affects the output.
Connected to T24-PA of ID FFC101 on channel 1
App: 1.2.2 | Drv COM: 1.7 | Drv DLL: 2.6

This module does not provide calibration, as such, because it is factory calibrated. However, on this page you can select the output type and parameters unique to your input sensor.

Items you can change:

Output Type	Simply select the required output type from the drop down list. Frequency (Hz) – Average frequency of pulses measured over the sample time Time (s) – Average time in seconds between pulses measured over the sample time RPM – Average Revolutions Per Minute measured over the sample time. Counter (Pulse counting input reset by digital input to GND or external reset using data provider packet – should not be used in low power mode
Pulses per Revolution	Specify the number of pulses per revolution. This parameter only affects the RPM output value.
Edge Type	Define which edge of an input pulse should be counted as the input trigger
Debounce Filter	Enter a time in milliseconds, any pulse that is received within this time of a previous pulse will be ignored, this is useful when dealing with noisy inputs such as relays which may inadvertently produce more than one pulse per event.
Ignore First Pulse	If set to yes the T24-PA will ignore first pulse received during the sample time, before continuing to average the time between the subsequent pulses. This is useful in situation where a sensor may be powered by the acquisition module and may produce an erroneous pulse on start up.

Advanced I/O


T24 Toolkit
Advanced I/O
Custom Output Value
Help
This page allows you to scale the displayed data and to alter the update rate of the LCD display.
Gain
1.0
Enter the gain to apply to the input value.
Offset
0.0
The offset to apply to the input value
Using a custom gain and offset you can change the output value. For example with an RPM output you could set a gain of 60 and an offset of zero to create RPS (Revolutions Per Second) output value
To display the input value without scaling Click Here
Input Value
0.0
Displayed Value
0.0
Shows the input value along with the scaled output value.
Reset Counter DataTag
FFFF
Enter the Data Tag that when received will reset the Counter if the output type is Counter
Back
Connected to T24-PA of ID FFC101 on channel 1
App: 1.2.2 | Drv COM: 1.7 | Drv DLL: 2.6

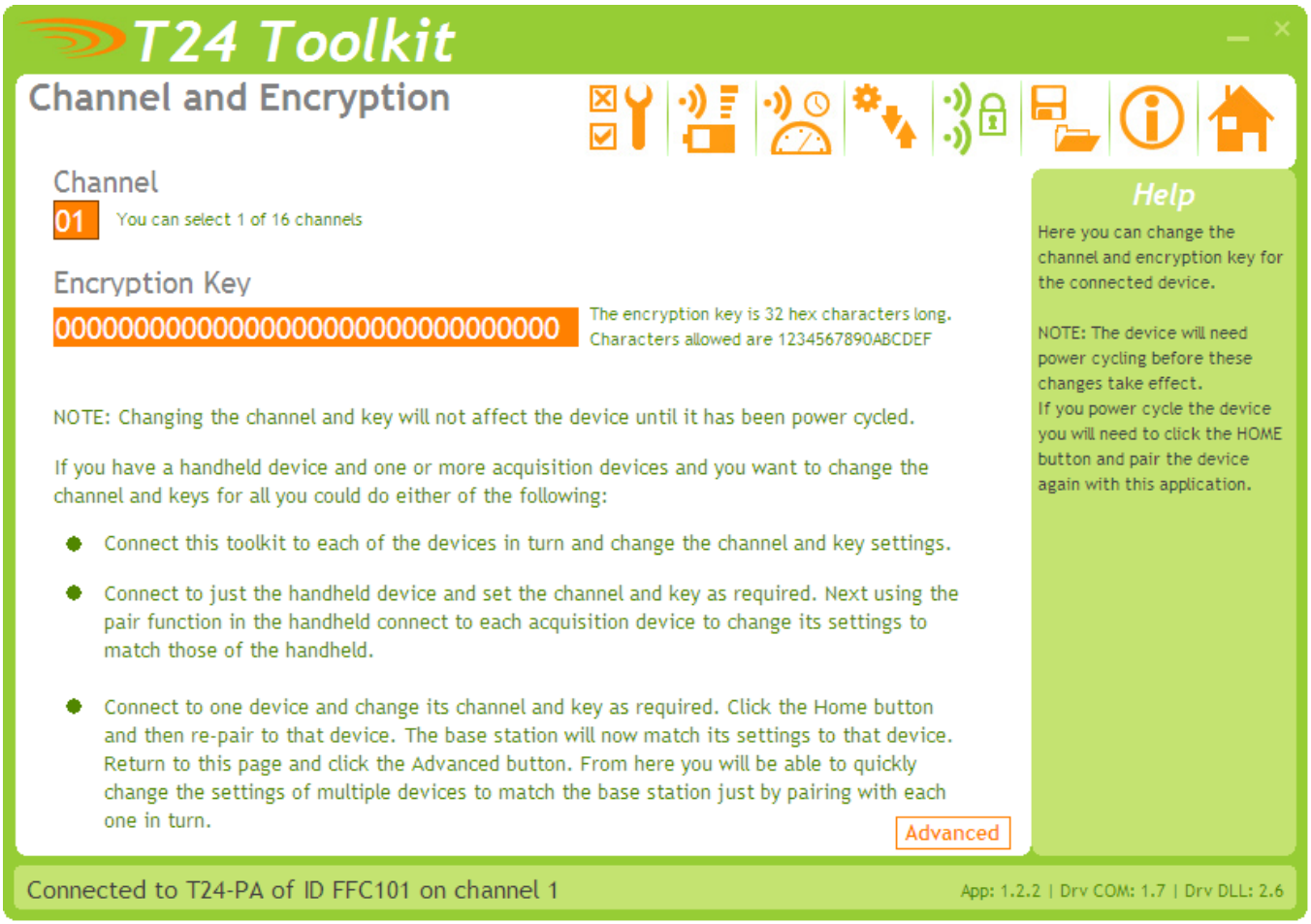
This module does not provide calibration, as such, because it is factory calibrated. However, on this page you can adjust the gain to provide different out put Types.

Custom Output Type

Items you can change:

Gain	Default is 1. If the gain value is set the output value of the module will be multiplied by the gain before transmission. This setting only applies to Frequency; Time & RPM outputs not the counter.
Offset	Default is 0. If the offset value is set the output value of the module will be multiplied by the gain and the offset subtracted before transmission. This setting only applies to Frequency; Time & RPM outputs not the counter.
Reset Counter Data Tag	If using the counter output the data tag specified in this field will cause the counter in the T24-PA to reset to zero whenever a data packet with this data tag is detected. Data providers can be produced by other acquisition modules, T24-HA or custom software

Channel and Encryption


T24 Toolkit
Channel and Encryption
Channel
01
You can select 1 of 16 channels
Encryption Key
00000000000000000000000000000000
The encryption key is 32 hex characters long.
Characters allowed are 1234567890ABCDEF
NOTE: Changing the channel and key will not affect the device until it has been power cycled.
If you have a handheld device and one or more acquisition devices and you want to change the channel and keys for all you could do either of the following:
Connect this toolkit to each of the devices in turn and change the channel and key settings.
Connect to just the handheld device and set the channel and key as required. Next using the pair function in the handheld connect to each acquisition device to change its settings to match those of the handheld.
Connect to one device and change its channel and key as required. Click the Home button and then re-pair to that device. The base station will now match its settings to that device. Return to this page and click the Advanced button. From here you will be able to quickly change the settings of multiple devices to match the base station just by pairing with each one in turn.
Advanced
Help
Here you can change the channel and encryption key for the connected device.
NOTE: The device will need power cycling before these changes take effect.
If you power cycle the device you will need to click the HOME button and pair the device again with this application.
Connected to T24-PA of ID FFC101 on channel 1
App: 1.2.2 | Drv COM: 1.7 | Drv DLL: 2.6

Here you can change the channel and encryption key for the acquisition module device.
If you want to change the channel of an acquisition module and T24-HS pair there is no need to change both devices.
Simply pair to the T24-HS handheld and change its channel and key.
Now perform pairing to the acquisition module from the handheld and the acquisition module will be configured to match the handheld.

NOTE: Early acquisition module do not yet utilise the encryption keys so these should be left at all zeros.

Items you can change:

Channel	Select a channel between 1 and 16. The default is channel 1. You can use the Spectrum Analyser mode to determine a good clean channel to use. NOTE: Channel 16 is used to negotiate pairing so avoid this channel if possible.
Encryption Key	Only devices with identical encryption keys can communicate. You can isolate groups of devices on the same channel or just use the key to ensure the data cannot be read by somebody else.

Save and Restore

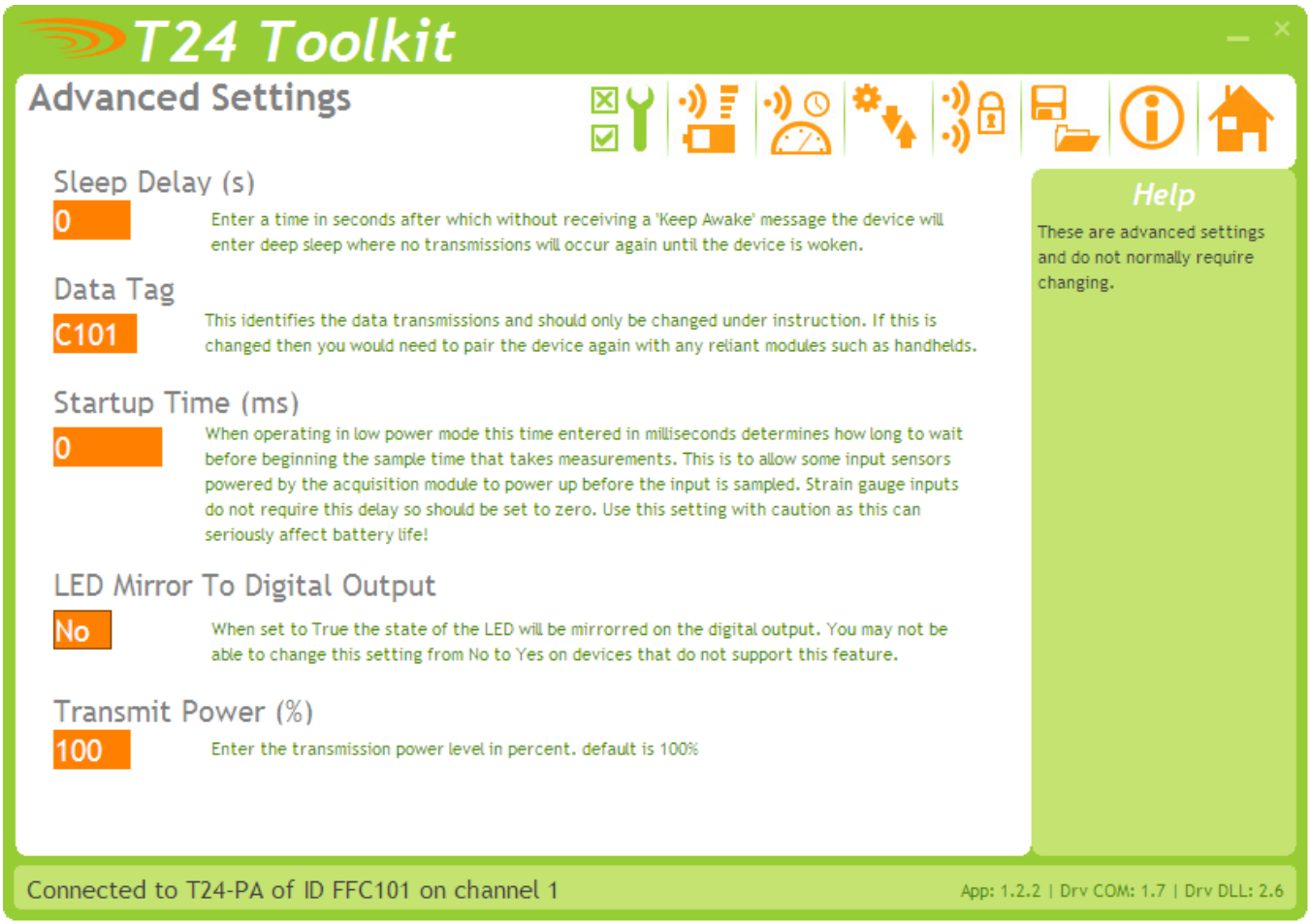
T24 Toolkit
Save and Restore
Save
Query the device for its parameters and save these to a configuration file on your computer or network location.
Restore
Load a previously saved configuration file into the currently connected device. NOTE: As all parameters are restored you will overwrite the existing device calibration information.
Help
This page allows you to save the configuration of the connected device to a disk file on your computer.
This file may then be used to restore the configuration to the same device or to clone the configuration onto another device.
Connected to T24-PA of ID FFC101 on channel 1
App: 1.2.2 | Drv COM: 1.7 | Drv DLL: 2.6

Here you can save the device settings to a file on your PC so that they can be later loaded back into the same or different device.

Items you can change:

Save	Click this button to open a file dialog window to allow you to select a filename and location to save the configuration file to. All configuration information including calibration data will be saved to the file. The file extension is **tcf**.
Restore	Click this button to open a file dialog window to allow you to select a filename and location of a previously saved file to load into the connected device. All configuration information **including** calibration data will be overwritten. The file extension is **tcf**.
Advanced Settings	Click this button to enter the Advanced Settings Page. Here are settings which do not normally require changing.

Advanced Settings


T24 Toolkit
Advanced Settings
Sleep Delay (s)
0
Enter a time in seconds after which without receiving a 'Keep Awake' message the device will enter deep sleep where no transmissions will occur again until the device is woken.
Data Tag
C101
This identifies the data transmissions and should only be changed under instruction. If this is changed then you would need to pair the device again with any reliant modules such as handhelds.
Startup Time (ms)
0
When operating in low power mode this time entered in milliseconds determines how long to wait before beginning the sample time that takes measurements. This is to allow some input sensors powered by the acquisition module to power up before the input is sampled. Strain gauge inputs do not require this delay so should be set to zero. Use this setting with caution as this can seriously affect battery life!
LED Mirror To Digital Output
No
When set to True the state of the LED will be mirrorred on the digital output. You may not be able to change this setting from No to Yes on devices that do not support this feature.
Transmit Power (%)
100
Enter the transmission power level in percent. default is 100%
Help
These are advanced settings and do not normally require changing.
Connected to T24-PA of ID FFC101 on channel 1
App: 1.2.2 | Drv COM: 1.7 | Drv DLL: 2.6

You should not normally need to change these settings.

Items you can change:

Sleep Delay	Here you can enter a delay in seconds after which the acquisition module will return to deep sleep if no Keep Awake message is heard from the T24-HS handheld. The default is 60 seconds.
Data Tag	The data transmitted by the acquisition module is marked with a Data Tag which is a 2 byte hexadecimal code. By default this is set to the last 2 bytes of the device ID (or to put it another way, the last 4 characters of the device ID). If by some chance you had two acquisition module devices that would be working on the same channel and had the same last 4 characters in their ID (1 in 65,535 chances) you may want to change the data Tag of one of the devices and perform pairing again with the T24-HS handheld.
Startup Time	Some acquisition modules power a sensor from their excitation voltage. When coupled to a sensor with a slow startup time this setting is used to delay the measurement after wakeup from sleep between readings. This gives the sensor time to settle at the expense of battery life. For strain gauge inputs this settings should be zero.
LED Mirror to Digital Output	When set to Yes each time the LED is active the digital output is active. This can be useful if the module is to be encapsulated or enclosed and enables a second LED to be externally mounted. This is very useful when using a T24-HR roaming handheld as the acquisition module LED will activate while the handheld is in communications with the module.
Transmit power	Set the transmit power level from 0 – 100%. Default is 100%

Installation

Overview

Radio performance at microwave wavelengths is very dependent upon the operating environment; any structure within the operating region of the radios will give rise to three effects:

Obscuration. Obscuration will result in reduced range and occurs when an obstruction masks the line-of-sight between radios.

Aberrations to the horizontal and vertical space patterns. Distortion of these patterns may occur if structures or objects are placed in the near or intermediate field of the antenna. The effect will be to distort the coverage patterns, adversely affecting range and link quality.

Reflection. Any object placed in line-of-sight of the transmit antenna will result in signals arriving at the receiver by an indirect path. Degradation of performance due to reflection (multipath effects) appears as reduced range or poor link quality.

Any of the above will cause poor RSSI figures, an increase in the packet loss rate and in extreme cases complete loss of signal. Fortunately, if consideration is given to these effects at the integration stage then a good quality link will be obtained.

Guidelines for product design:
When selecting materials for product enclosures, preference should be given to fibreglass, light coloured ABS or Polypropylene; at the wavelength of 2.4GHz radio other materials will adversely affect the signal by attenuation, refraction or change in polarisation.

If the application demands that the radio is fitted inside a metal enclosure then ensure that the specified clearances are maintained around the antenna and design in a fibreglass RF window at least as large as the clearance dimensions but ideally as large as possible.

RAD24i radios fitted inside a product should be oriented so that the chip antenna will be vertical when the product is in its normal operating position.

Guidelines for installation:
When planning installations ensure that line-of –sight between nodes is maintained and that objects or structures are kept at least one metre away from antennae wherever possible.

To avoid poor link quality between a RAD24i radio and a handheld device ensure that the RAD24i is mounted so that the chip antenna is vertical. Improvement may also be obtained by altering the height above ground of the RAD24i; a small increase or reduction in antenna elevation will often improve reception.

Range underwater is only a decimetre or so depending on packet rate. Best performance underwater is obtained by using low packet rates and immersing water-proofed antennae rather than water-tight enclosures containing the antennae.

Power Supply / Battery

The acquisition module operates from 2.1 to 3.6 Volts dc so can be supplied from a variety of cells.

WARNING: It is important to note that the acquisition module is NOT reverse polarity protected!

WARNING: The maximum voltage is 3.6V!

Considerations When Selecting Batteries

Re-chargeable or replacement
This really depends on the application. Some applications where expected battery life with alkaline batteries will be many years would probably not warrant the use of re-chargeable batteries. Re-chargeable batteries have implementation issues such as how to connect to the charger, how to seal this connection if required, can the batteries be re-charged at a convenient point in the operation of the device I.E between shifts and does the voltage, when charging, exceed the maximum supply voltage of the acquisition module if so the inline charging module will need to be fitted.

Required battery life
Driven by the application and mainly dependent on measurement rate and sample time. The operation would normally require that the acquisition module is used in Low Power Mode to maximise battery life.

Size of
Choosing a battery will be influenced by how much space is available and what battery life is required, generally the bigger the battery the longer it will last.

Operating temperature range
A batteries useable capacity is influenced by its operating temperature. Generally, the lower the temperature the lower their ability to provide charge. Beware of the batteries specified operating range when considering a particular battery technology.

Self discharge.
Batteries are chemical devices and have a shelf life which needs to be considered in application where long battery life is required. Typically an Alkaline has a battery life of 5 years.

Internal Resistance of battery
Low internal resistance is important, the higher the resistance the less useful life of the battery is available. This is due to voltage drops caused during the high current phase of the measurement cycle. Batteries with an internal resistance of less than 150mOhm will not require the additional inline capacitor module.

Connections to battery
For the same reasons internal resistance must be low it is important to keep any voltage drops from the battery to the acquisition module as low as possible too. Care must be taken in selecting the connection method between batteries and acquisition module. For example cables should be kept as short and thick as possible.

Environmental
Other considerations when selecting a connection method to the Batteries is the effect of vibration. A standard battery holder is a poor choice in applications when the device can be subject to vibration. This is due to the interruption of supply from the battery to the acquisition module caused when the spring arrangement holding the battery to the terminal of the holder is defeated.
Corrosion of terminals must also be considered as this will also introduce resistance into the supply connections. This could be overcome by ensuring the enclosure is sealed.

Optimising battery life
Battery life can be optimised by considering the following.

- Use of low power mode.
- Transmission interval.
- Required Measurement resolution (Sample time).
- Sleep / Wake configuration
- Auto-Sleep duration.

Battery Types

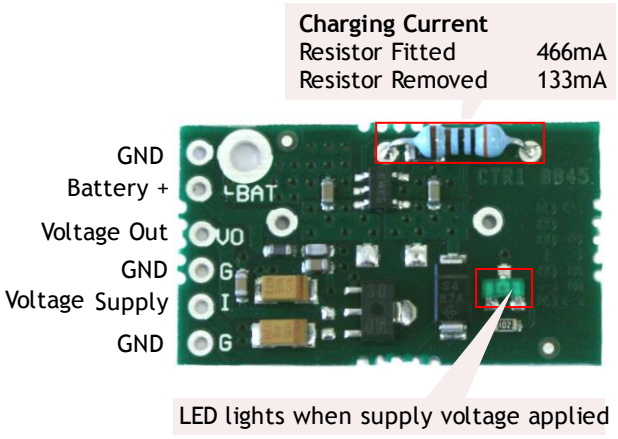
Battery Type	Notes
Alkaline $Zn\text{-}MnO_2$	Pairs of alkaline 1.5V cells are the most common. Use D cells for maximum life and AA cells where space is restricted. Example: Varta 4014 (D), Varta 4006 (AA) **Recommend T24-BC2 module** to maximise usable capacity.
Nickel Metal Hydride NiMh	Most cells are 1.2V so two in series gives 2.4 Volts. These can match alkaline batteries in capacity but as the charged voltage is lower they do not match the usable capacity. These batteries self discharge at a faster rate than alkalines. If charging these cells in circuit precautions must be taken to ensure that the maximum voltage on the acquisition module is not exceeded. Example: GP 270AAHC (AA) **Recommend T24-BC2 module** to maximise usable capacity.
Nickel Cadmium NiCad	Most cells are 1.2V so two in series gives 2.4 Volts. Three in series can be used to give 3.6 Volts. These do not have the usable capacity of an alkaline battery. These are generally only useful if they are to be charged on a regular basis. If charging these cells in circuit precautions must be taken to ensure that the maximum voltage on the acquisition module is not exceeded. Example: **Recommend T24-BC2 module to maximise usable capacity.**
Lithium Primary 3.6V $Li\text{-}SOCl_2$	Lithium cells can be used but note that the maximum voltage is 3.6 Volts. Select a cell with low internal resistance. Example: Saft LS17500 (A), Saft LSH20 (D) **Recommend T24-BC1 module** as these cells usually have a high internal resistance.
Lithium Iron Disulphide $Li\text{-}FeS_2$	These can be found at 1.5 Volts and can therefore be a direct replacement for Alkaline cells. The low internal resistance and high capacity make these batteries an ideal choice. Example: Energizer L91
Lithium Ion and Lithium Polymer LiON, LiPo	These generally start at 3.7V and exceed the maximum allowable voltage. These are usable if a regulator and charging circuit can be installed between the acquisition module and the battery. Care must be taken here that the regulator does not draw too much current when idle so that the low power modes are not compromised. **Recommend T24-BC1 module.**

Power Supply Modules

Lithium Ion /Polymer Module T24-BC1

The T24-BC1 is a battery charger and power supply suitable for the T24 range of 3V acquisition modules. The T24 Battery Charger is designed to supply a constant 3.3V from a Li-ion Battery while also charging the battery from an input voltage. The unit comes pre-configured to provide a charging current of 466mA suitable for VARTA LIP653450. This module also supports additional batteries providing a charge current of 133mA via the removal of the leaded resistor (non surface mount).

Physical Connections



Specification

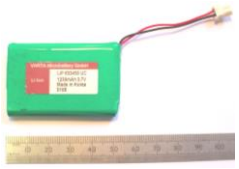
Parameter	Min	Typ	Max	Units
Supply Voltage	4.1	5	6	V
Regulated Voltage Output	-	3.3	-	V
Battery positive connection	-	3.7	-	V
Maximum Cable Length	-		150	mm
Quiescent Current		1.7		µA

Note LED will only be lit when an input voltage is applied

Suitable Batteries

VARTA LIP653450

- Rated Capacity: 1100mAh
- Dimensions: 35 x 54 x 7 (mm)
- Weight: 20g
- Charge Time : 3 Hours @ 466mA
- Battery life = 2 months 1 days*



VARTA LIC18650

- Rated Capacity: 2200mAh
- Dimensions: 18.25 Diameter 65mm Height
- Weight: 46g
- Charge Time : 4.5 Hours @ 466mA
- Battery life = 4 months 2 days*

UBC 581730

- Rated Capacity: 250mAh
- Dimensions: 18 x 31.5 x 5.8 (mm)
- Weight: 6.5g
- Charge Time : 2 Hours @ 133mA
- Battery life = 13 days 23 hours*

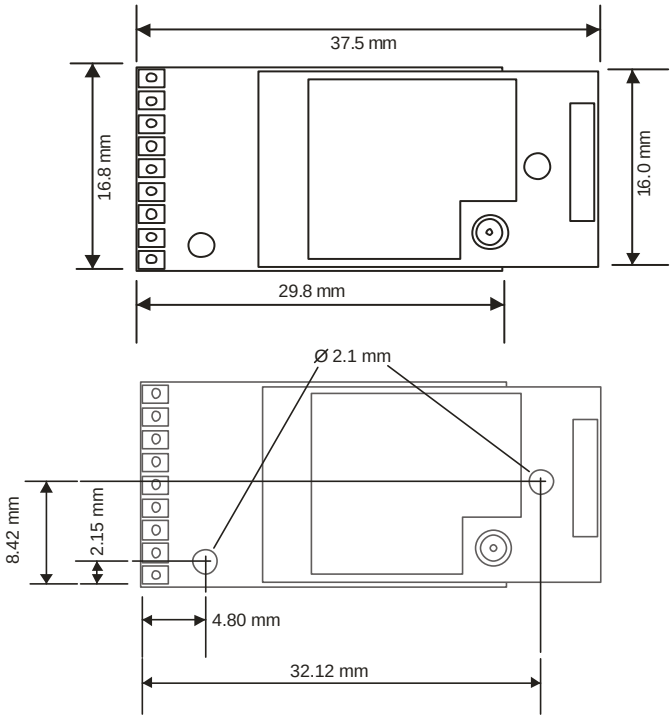
* Note: Battery life is calculated with a T24-PA running in low power mode with a sample time of 5mS and transmit interval of 333mS for 2 hours out of every 8 hours.

Capacitor Module T24-BC2

This is used for batteries which have an internal resistance of greater than 150mOhms overcoming voltage drops during high current phases of the low power mode cycle.
This problem becomes apparent when attempting to communicate with high peak current acquisition modules such as a T24-PA using the T24 Toolkit or power cycling when the battery is near the end of its life. In normal operation (Low power mode) with a handheld T24-HS where the T24-PA is connected to an uninterrupted battery this module is generally not required.
Using lower impedance strain gauges (or multiple parallel strain gauges) exacerbates this problem.
Consult Sales for details. Alternatively fit an electrolytic capacitor across battery of 2000uF or greater. This capacitor should be of low ESR (< 70mOhms).

Mounting

Mechanical size



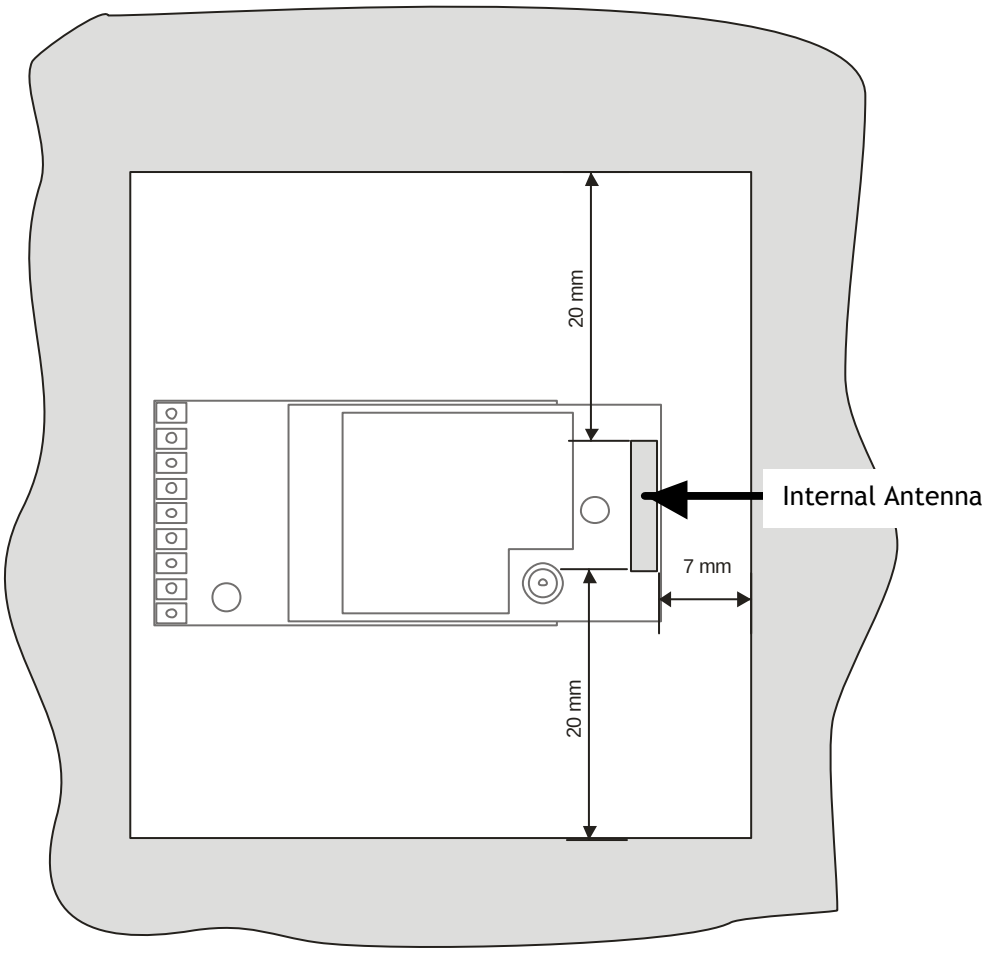
There are two holes available for mounting. The one nearest the connection pads can accept an M2 screw or American equivalent #0-80. Important Note: DO NOT USE #2 screw size. Note that the mounting hole is connected directly to the Battery ground of the acquisition module.
The mounting hole near the chip antenna cannot accept metal mounting hardware.

The connection holes are on a 1.9mm pitch and are a diameter of 1mm.

Antenna

Internal Chip Antenna

There must be no metal objects within 7mm of the antennas long edge and 20mm from the short edges. See diagram below



External Antenna Option

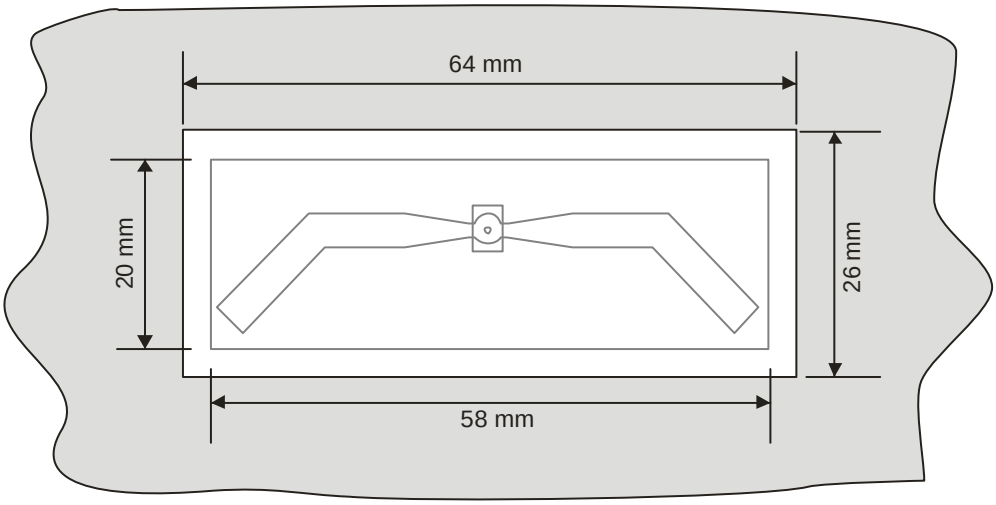
Use of a T24 external antenna requires a T24 acquisition module with a UFL connector stud in place of the on-pcb antenna.

T24 acquisition modules fitted with a UFL stud have a suffix ‘e’ to the part number e.g. T24-SAe

Note: The suffix ‘e’ is omitted where the T24 acquisition module is fitted inside a T24-ACM or T24-ACMi enclosure e.g. T24-ACM-SA, T24-ACMi SA

External Antennas

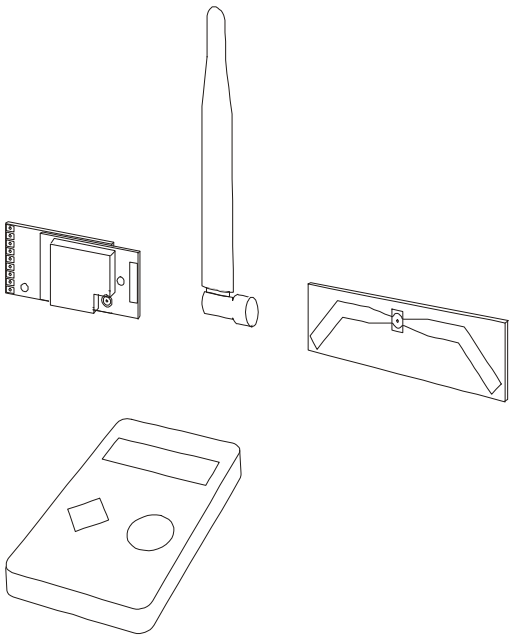
The external antennas come in two styles.
The flat PCB antenna can be mounted inside a plastic housing or to the outside of a metal housing. The PCB requires 3mm Clearance on all edges, this also applies to the RF window.



The bulkhead mounting antenna can be used with metal or plastic housings. Care must be taken when mounting the Antenna to ensure the installation does not become directional.

Antenna Orientation

For the maximum range the acquisition module and any other modules should be orientated as shown.
The sensitivity to the radio transmission will be reduced if the acquisition module is oriented in a vertical or portrait position if a handheld is used because the handheld can only be used in one orientation.



Specifications

General Radio

	Min	Typical	Max	Units
License		License Exempt		
Modulation method		MS (QPSK)		
Radio type		Transceiver (2 way)		
Data rate		250		K bits/sec
Radio Frequency	2.4000		2.4835	GHz
Power		1		mw
Range RAD24i (Integrated antenna)			100 (325)	Metres (feet) *
Range RAD24e (External antenna)			200 (650)	Metres (feet) *
Channels (DSSS)		16		

* Maximum range achieved in open field site at a height of 3 metres above ground.

T24-PA

Specification at 3V supply at 25°C

Measurement	Min	Typical	Max	Units
Sensor Excitation Voltage	4. 5	5	5.25	V DC
Input Range in Time	333 x10^{-6}	-	2	sec
Input Range in Frequency	0.5	-	3,000	Hz
Input Range in RPM (presuming 1 pulse / rev)	30	-	180,000	RPM
Accuracy % input error @ 1 Hz	-	-	0.15	%
Accuracy % input error @ 1 kHz	-	-	0.175	%
Accuracy % input error @ 2 kHz	-	-	0.2	%
Accuracy % input error @ 3 kHz	-	-	0.25	%
Accuracy interval resolved to		0.25		µ sec

Electrical				
Power Supply voltage	2.1	3.0	3.6	V DC
Power Supply ripple			50	mV AC pk-pk

Power Supply current				
Normal Mode		35	65	mA
Standby / Low power mode		5	40	uA

Environmental				
Operating temperature range	-40		+85	°C
Storage temperature	-40		+85	°C
Humidity	0		95	%RH

Physical	
PCB Dimensions	16.8 x 37.5 x 6.5mm

Approvals

CE

CE

Complies with EMC directive. 2004/108/EC
The Radio Equipment and Telecommunications Terminal Equipment (R&TTE) Directive, 1999/5/EC,

European Community, Switzerland, Norway, Iceland, and Liechtenstein

English:	This equipment is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.
Deutsch:	Dieses Gerät entspricht den grundlegenden Anforderungen und den weiteren entsprecheneden Vorgaben der Richtlinie 1999/5/EU.
Dansk:	Dette udstyr er i overensstemmelse med de væsentlige krav og andre relevante bestemmelser i Directiv 1999/5/EF.
Español:	Este equipo cumple con los requisitos esenciales asi como con otras disposiciones de la Directive 1999/5/EC.
Français:	Cet appareil est conforme aux exigencies essentialles et aux autres dispositions pertinantes de la Directive 1999/5/EC.
Íslenska:	Þessi búnaður samrýmist lögboðnum kröfum og öðrum ákvæðum tilskipunar 1999/5/ESB.
Italiano:	Questo apparato é conforme ai requisiti essenziali ed agli altri principi sanciti dalla Direttiva 1999/5/EC.
Nederlands:	Deze apparatuur voldoet aan de belangrijkste eisen en andere voorzieningen van richtlijn 1999/5/EC.
Norsk:	Dette utstyret er i samsvar med de grunnleggende krav og andre relevante bestemmelser i EU-directiv 1999/5/EC.
Português:	Este equipamento satisfaz os requisitos essenciais e outras provisões da Directiva 1999/5/EC.
Suomalainen:	Tämä laite täyttää direktiivin 1999/5/EY oleelliset vaatimukset ja on siinä asetettujen muidenkin ehtojen mukainen.
Svenska:	Denna utrustning är i överensstämmelse med de väsentliga kraven och andra relevanta bestämmelser i Direktiv 1999/5/EC.

This equipment is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.

FCC

FC

Family: RAD24
Models: i and e for internal and external antenna variants. For antenna T24-ANTA and T24-ANTB
FCC ID:VHARAD24
This device complies with Part 15c of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

CAUTION: If the device is changed or modified without permission from Mantracourt Electronics Ltd, the user may void his or her authority to operate the equipment.

Industry Canada

Models: i and e for internal and external antenna variants. For antenna T24-ANTA and T24-ANTB
IC:7224A-RAD24
This apparatus complies with RSS-210 - Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment RSS.

OEM / Reseller Marking and Documentation Requirements

FCC

The Original Equipment Manufacturer (OEM) must ensure that FCC labelling requirements are met. This includes a clearly visible label on the outside of the final product enclosure that displays the contents as shown:

> Contains FCC ID:VHARAD24
>
> This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:
>
> (1) this device may not cause harmful interference and
>
> (2) this device must accept any interference received, including interference that may cause undesired operation.

The acquisition modules have been tested with T24-ANTA and T24-ANTB. When integrated in OEM products, fixed antennas require installation preventing end-users from replacing them with non-approved antennas. Antennas other than T24-ANTA and T24-ANTB must be tested to comply with FCC Section 15.203 (unique antenna connectors) and Section 15.247 (emissions).

Acquisition modules have been certified by the FCC for use with other products without any further certification (as per FCC section 2.1091). Changes or modifications not expressly approved by Mantracourt could void the user's authority to operate the equipment.

In order to fulfil the certification requirements, the OEM must comply with FCC regulations:
1. The system integrator must ensure that the text on the external label provided with this device is placed on the outside of the final product.
2. The acquisition modules with external antennas may be used only with Approved Antennas that have been tested by mantracourt.

IC

Labelling requirements for Industry Canada are similar to those of the FCC. A clearly visible label on the outside of the final product enclosure must display the following text:

> Contains Model RAD24 Radio (2.4 GHz), IC:7224A-RAD24

Integrator is responsible for its product to comply with RSS-210 - Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment RSS.

CE

The T24 series has been certified for several European countries.
If the acquisition module is incorporated into a product, the manufacturer must ensure compliance of the final product to the European harmonized EMC and low-voltage/safety standards. A Declaration of Conformity must be issued for each of these standards and kept on file as described in Annex II of the R&TTE Directive. Furthermore, the manufacturer must maintain a copy of the T24 device user manual documentation and ensure the final product does not exceed the specified power ratings, antenna specifications, and/or installation requirements as specified in the user manual. If any of these specifications are exceeded in the final product, a submission must be made to a notified body for compliance testing to all required standards.

OEM Labelling Requirements

The ‘CE’ marking must be affixed to a visible location on the OEM product.

The CE mark shall consist of the initials “CE” taking the following form:

- If the CE marking is reduced or enlarged, the proportions given in the above graduated drawing must be respected.
- The CE marking must have a height of at least 5mm except where this is not possible on account of the nature of the apparatus.
- The CE marking must be affixed visibly, legibly, and indelibly.

Declaration Of Conformity

We, **Mantracourt Electronics Limited**
The Drive
Farringdon
Exeter
Devon EX5 2JB
declare under our sole responsibility that our products in the **T24 Radio Telemetry Product Range** to which this declaration relates are in conformity with the appropriate standard EN 300 328 following the provisions of the Radio and Telecommunications Terminal Equipment Directive **1999/5/EC**, **FCC CFR Title 47** part 15c BS EN 61000-4-2 and BS EN 61000-4-3 following the provisions of the EMC Directive **2004/108/EC** and Low Voltage Directive **2006/95/EC**.

December 2007

Brett James
Development Manager
Mantracourt Electronics Limited.

FCC ID:VHARAD24

CE

Worldwide Regional Approvals

Region	Product Conforms To
Europe	CE
USA	FCC
Canada	IC
Australia	To Be Determined
China	To Be Determined
Japan	To Be Determined

Important Note

Mantracourt does not list the entire set of standards that must be met for each country. Mantracourt customers assume full responsibility for learning and meeting the required guidelines for each country in their distribution market. For more information relating to European compliance of an OEM product incorporating the T24 range of modules, contact Mantracourt, or refer to the following web site: **www.ero.dk**

Warranty

All Telemetry products from Mantracourt Electronics Ltd., ('Mantracourt') are warranted against defective material and workmanship for a period of (1) one year from the date of dispatch.
If the 'Mantracourt' product you purchase appears to have a defect in material or workmanship or fails during normal use within the period, please contact your Distributor, who will assist you in resolving the problem. If it is necessary to return the product to 'Mantracourt' please include a note stating name, company, address, phone number and a detailed description of the problem. Also, please indicate if it is a warranty repair.
The sender is responsible for shipping charges, freight insurance and proper packaging to prevent breakage in transit.
'Mantracourt' warranty does not apply to defects resulting from action of the buyer such as mishandling, improper interfacing, operation outside of design limits, improper repair or unauthorised modification.
No other warranties are expressed or implied. 'Mantracourt' specifically disclaims any implied warranties of merchantability or fitness for a specific purpose. The remedies outlined above are the buyer's only remedies. 'Mantracourt' will not be liable for direct, indirect, special, incidental or consequential damages whether based on the contract, tort or other legal theory.
Any corrective maintenance required after the warranty period should be performed by 'Mantracourt' approved personnel only.

Industry Canada
Industrie Canada

Designed, manufactured and supported in the UK

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